Galactic Observer

John J. McCarthy Observatory

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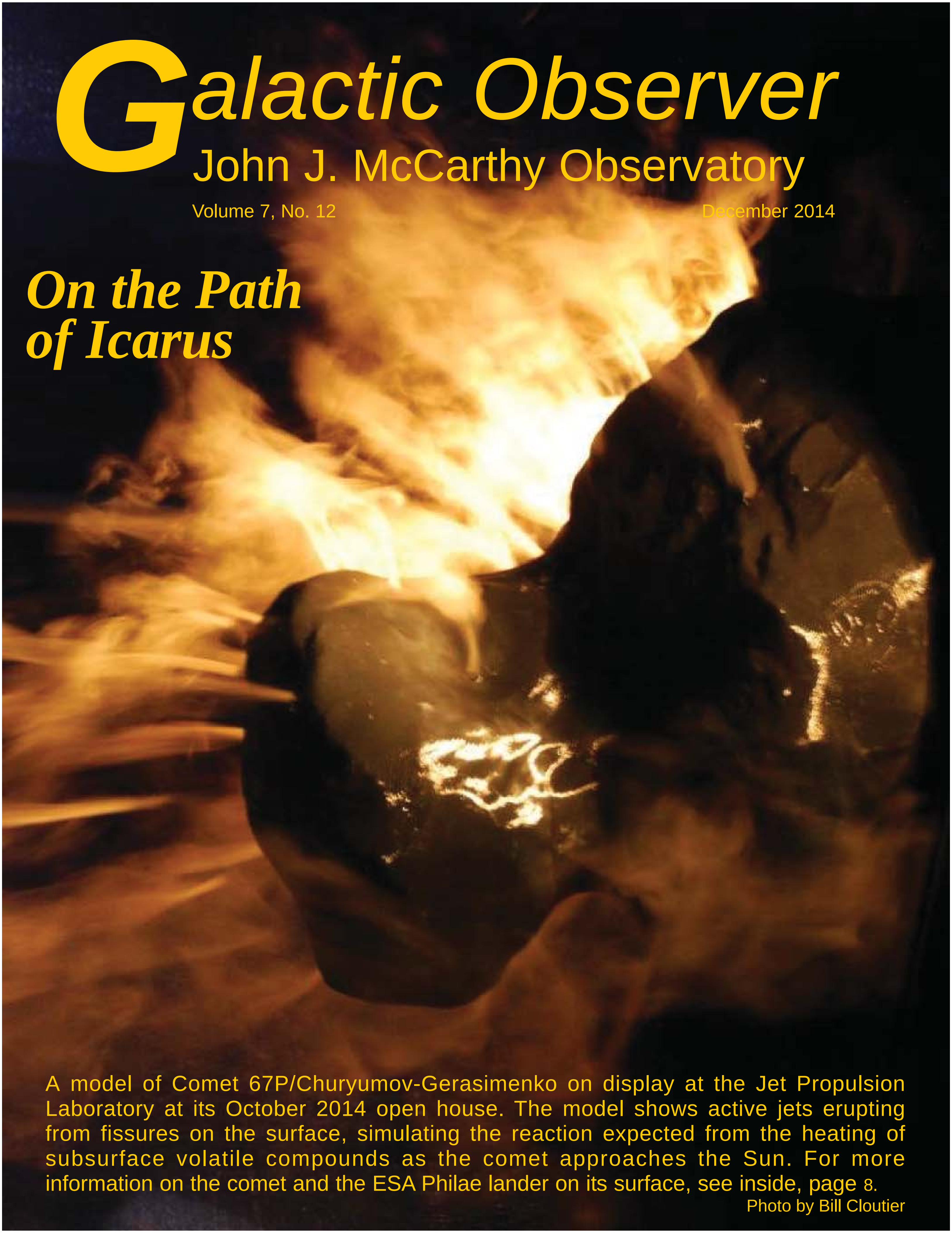

On the Path of Icarus

A model of Comet 67P/Churyumov-Gerasimenko on display at the Jet Propulsion Laboratory at its October 2014 open house. The model shows active jets erupting from fissures on the surface, simulating the reaction expected from the heating of subsurface volatile compounds as the comet approaches the Sun. For more information on the comet and the ESA Philae lander on its surface, see inside, page 8.

Photo by Bill Cloutier

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It is through their efforts that the McCarthy Observatory has established itself as a significant educational and recreational resource within the western Connecticut community.

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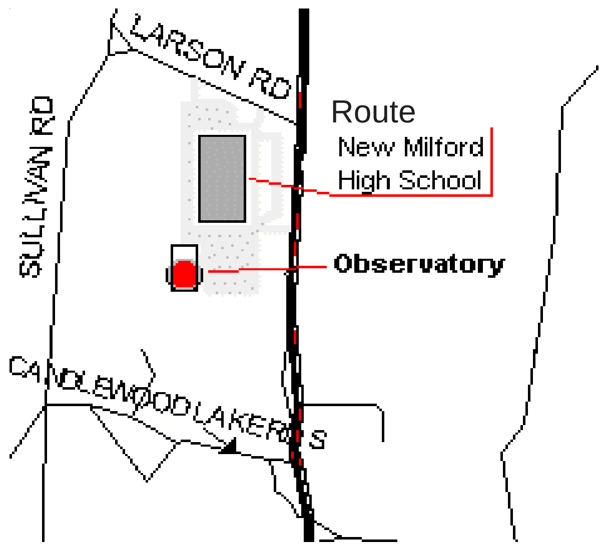


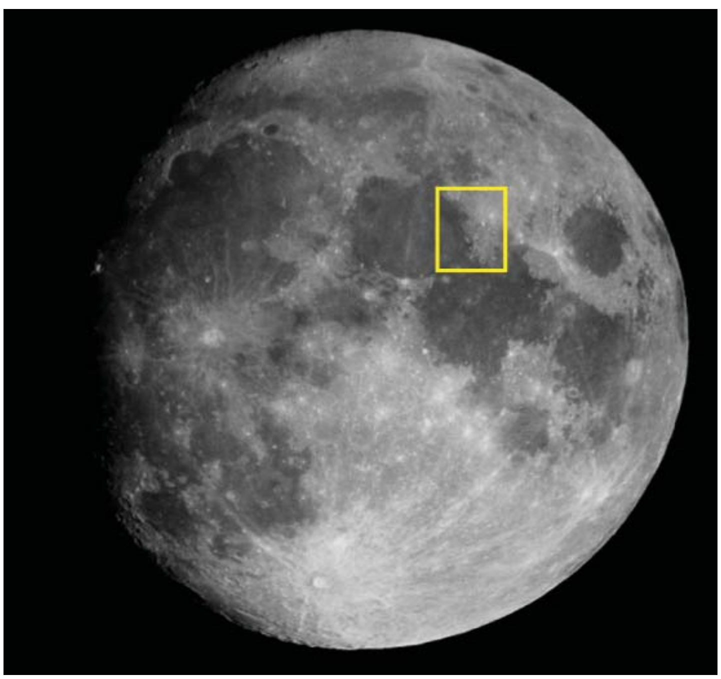
In This Issue

December Astronomy Calendar and Space Exploration Almanac

"Out the Window on Your Left"

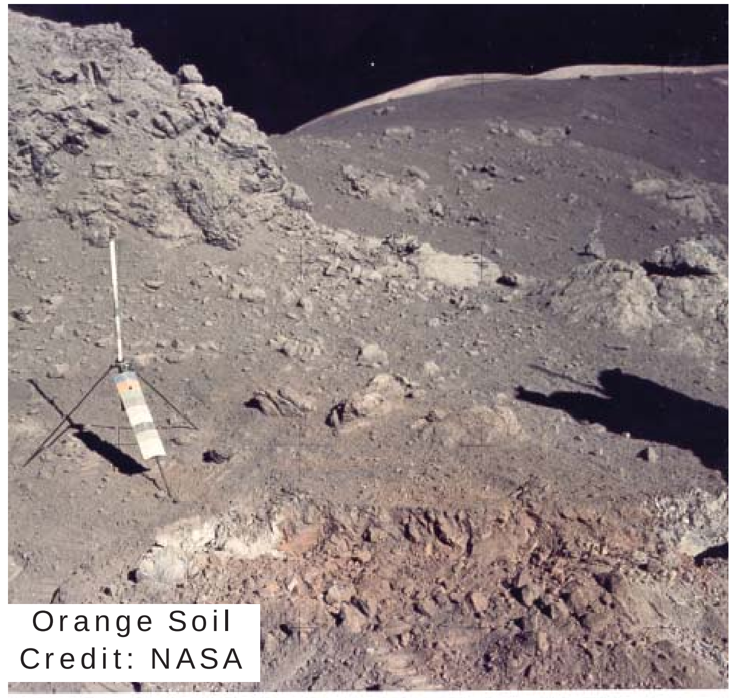
It's been more than 40 years since we left the last footprint on the dusty lunar surface. Sadly, as a nation founded on exploration and the conquest of new frontiers, we appear to have lost our will to lead as a space-faring nation. But, what if the average citizen had the means to visit our only natural satellite; what would they see out the window of their spacecraft as they entered orbit around the Moon? This column may provide some thoughts to ponder when planning your visit (if only in your imagination).

The sun rises on the Taurus-Littrow valley this month, a narrow opening in the rim of the Serenitatis Basin. The valley is enclosed on three sides by large mountains: the South Massif, North Massif, and East Massif. It is also the landing site of Apollo 17 on December 11, 1972, the final lunar mission of the Apollo program.



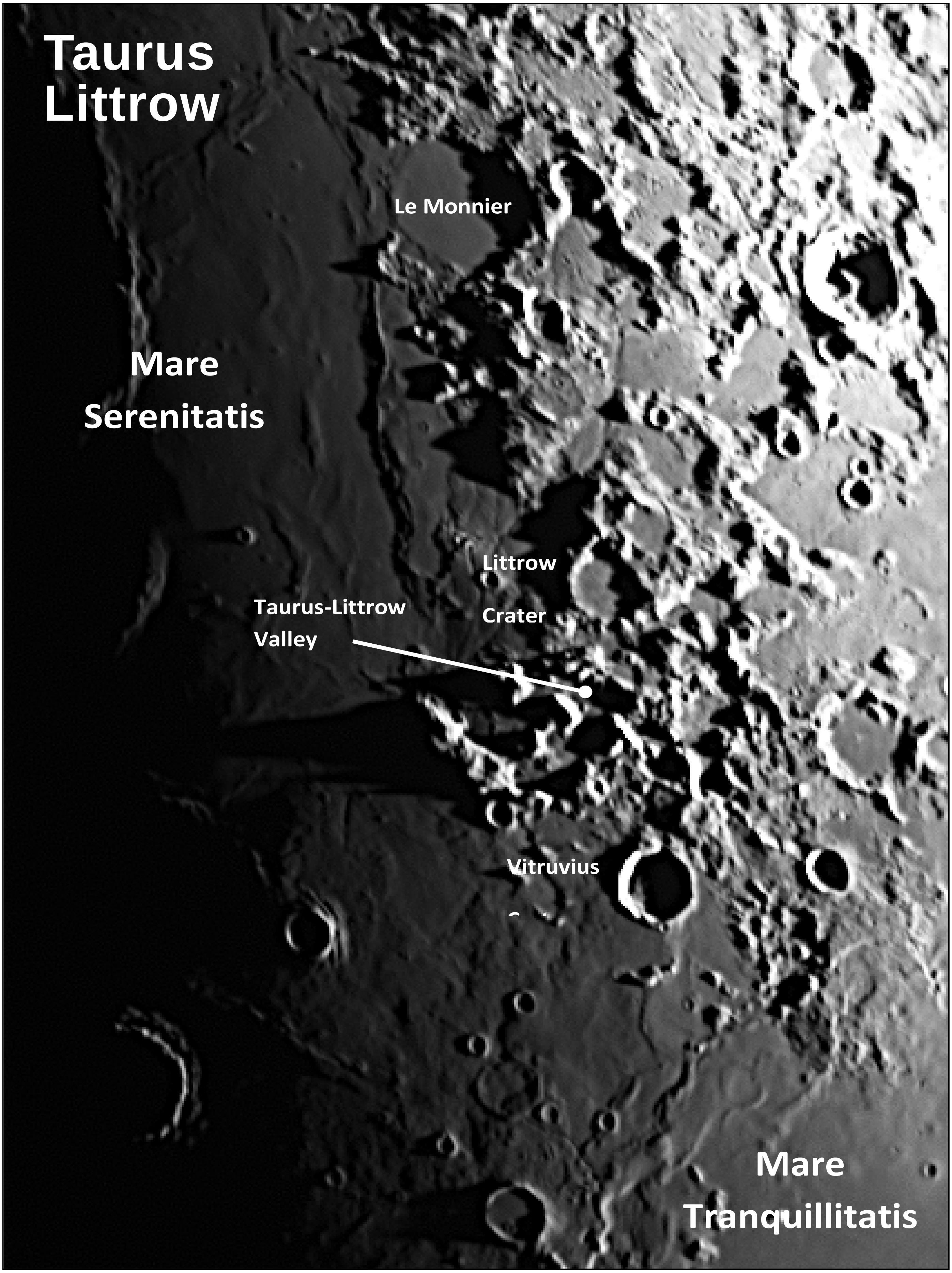
Multiple sites competed for the last mission offering a variety of terrains, history and geology. Taurus-Littrow provided astronauts, including geologist Harrison Schmitt, the opportunity to explore craters on the valley floor with dark halos that had been identified from orbit by earlier missions. The lunar module was set down near one of these craters, designated Shorty.

It was on the rim of Shorty that Schmitt discovered a deposit of "orange soil." The orange particles were later determined to be volcanic glass, likely produced by a volcanic vent or fire fountain. The glass formed 3.64 billion year ago from material that melted several hundred miles below the surface. The glass was buried and later excavated by impacts.



Orange Soil
Credit: NASA

A microscopic view of the orange soil by the Lunar and Planetary Institute shows the orange volcanic glass and black ilmenite.


Taurus
Littrow
Le Monnier
Mare
Serenitatis
Littrow
Crater
Taurus-Littrow
Valley
Vitruvius
Mare
Tranquillitatis

New Horizons Kuiper Belt Target Found

In less than a year, the New Horizons spacecraft will make a high-speed pass by the dwarf planet Pluto and its five moons. At its closest approach (approximately 6,200 miles or 10,000 km from Pluto), the spacecraft will be traveling 31,300 mph (14 km/sec). Detailed observing opportunities will begin approximately 12 hours prior to New Horizon's closest approach to Pluto and extend approximately 12 hours after its encounter. Without the energy (fuel) to slow down and enter orbit around Pluto, New Horizons will continue out into the Kuiper Belt, a disk-shaped zone of icy remnants of the solar system's formation.

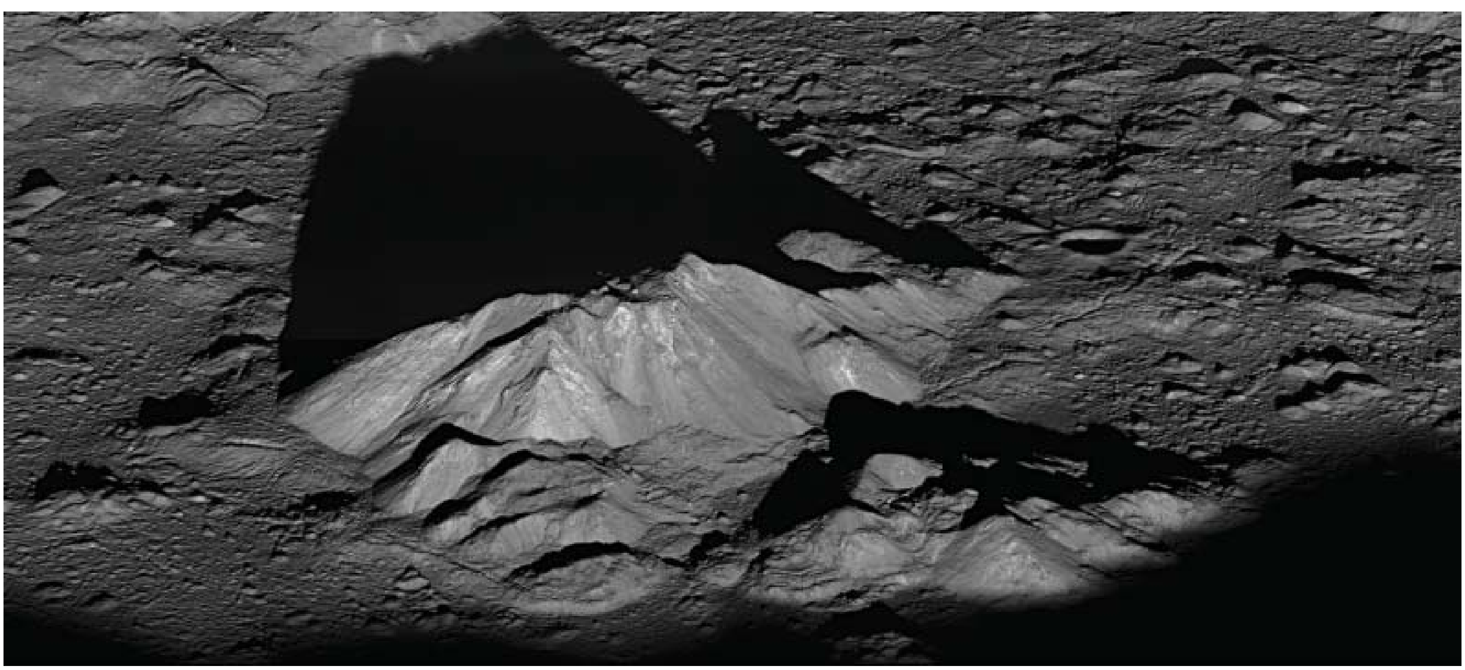
For several years NASA has been looking for secondary targets (Kuiper Belt Objects or KBOs) that would be within the reach of New Horizons. However, it wasn't until recently, with the aid of the Hubble Space Telescope, that suitable candidates were found. Five potential targets were identified during a search conducted between June and August. Two were later ruled out in follow up observing campaigns, leaving three targets that are potentially within New Horizons' reach. The three potential targets range in size between 18 to 36 miles (30 to 60 km).

Of the three, there is a 100% probability that New Horizons can reach one (a KBO designed PT1 or 1110113Y) with fuel to spare. PT1 has a circular orbit within the plane of the solar (as compared to Pluto's highly inclined orbit) and could be a remnant of the solar system's primordial disk. It is estimated that New Horizons could reach PT1 in January of 2019 at an estimated distance of 43.4 AU (more than 4 billion miles) from the Sun and more than 1 billion miles beyond Pluto.

An image of PT1 taken in multiple exposures by the Hubble Space Telescope. Source: NASA.

Moon as Art

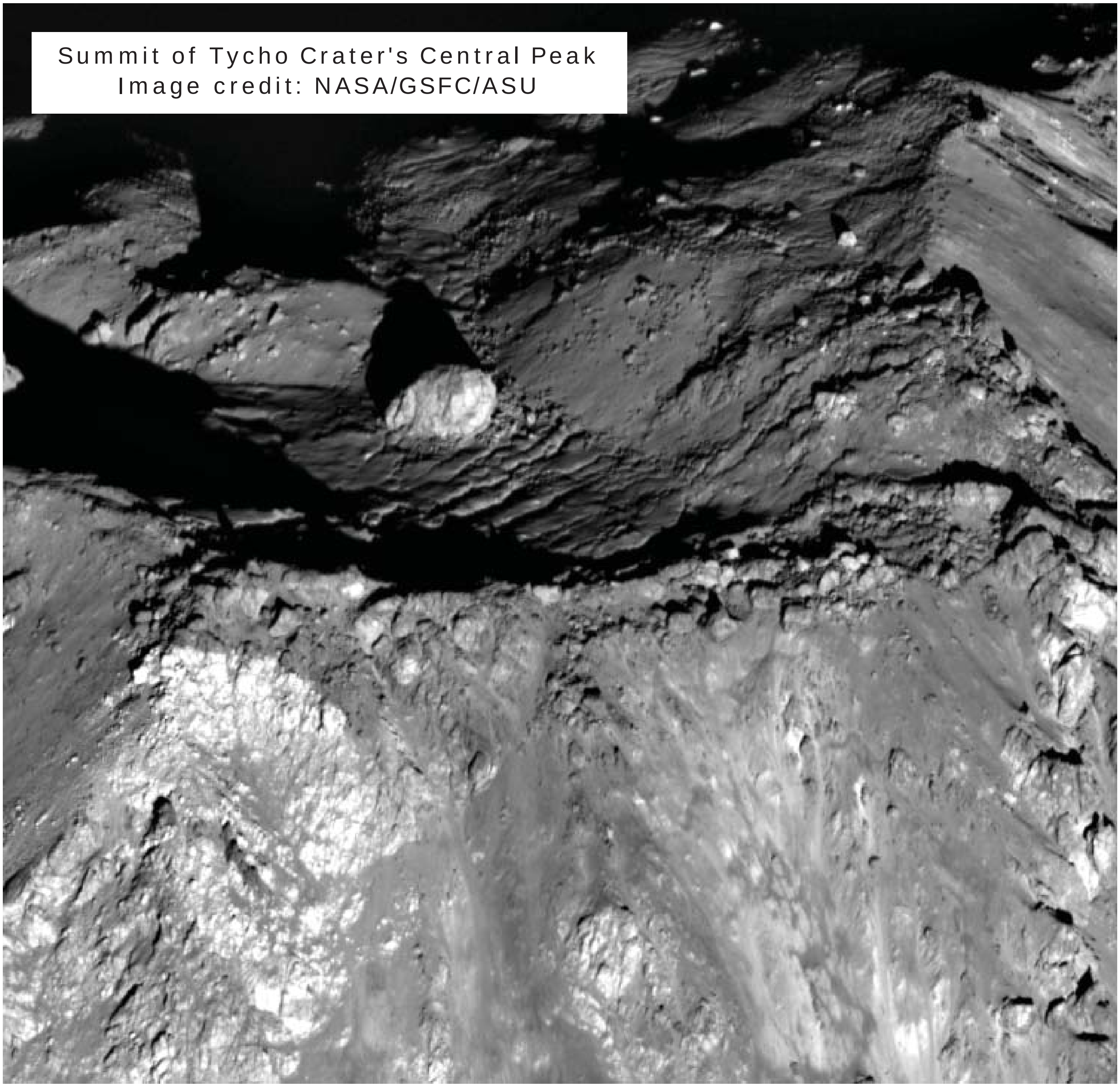
This summer, the Lunar Reconnaissance Orbiter (LRO) project sponsored a "Moon as Art" contest in celebration of the spacecraft's fifth anniversary. The public was asked to select their favorite from a suite of images captured over the first 4.5 years of operation. The winner of the contest was a photo of Tycho Crater's central peak.



Tycho Crater's Central Peak. Image credit: NASA/GSFC/ASU

In the image, LRO captured the shadows of the peak stretching across the crater's floor at sunrise. The crater is approximately 51 miles (82 km) in diameter and geologically young (110 million years old). Its sharp features are indicative of its recent formation (lunar features are softened by a relentless bombardment of space debris over the eons). The summit of the peak is approximately 6,562 feet (2 km) above the crater's floor.

Individual boulders can be seen in this close-up of the summit. The large boulder visible near the center of the depression is approximately 400 feet across (120 meters).



Summit of Tycho Crater's Central Peak
Image credit: NASA/GSFC/ASU

Launch Milestone

In December 2006, Lockheed Martin and the Boeing Company formed a joint venture: United Launch Alliance (ULA). The venture was able to offer a range of services to a variety of clients with two established launch vehicles: Atlas and Delta.

On October 29, 2014, ULA successfully launched a Global Positioning satellite for the U.S. Air Force, its 89th successful launch since the venture was formed and the 50th flight of its Atlas V rocket. The image (below), from an on-board camera, captures the staging of the Atlas V from the Centaur upper stage. The upper stage is powered by a single Aerojet Rocketdyne engine.

Staging of the Atlas rocket
Credit: ULA

China's Sample Return Mission

On October 23, 2014, China launched its Chang'e 5 test vehicle (nicknamed "Xiaofei" or "little flyer") on an eight day deep-space mission. The 520,000 mile (840,000 km) roundtrip took the spacecraft around the far side of the Moon before returning to Earth. The landing capsule separated from the mothership in Earth orbit prior to re-entry.

The mission was designed to test the spacecraft's heat shield technology, high-speed re-entry performance and sample recovery procedures. The mission is in preparation for a more complicated and ambitious lunar sample return mission.

Credit: Xinhua/
Jiang Hongjing

China is expected to launch Chang'e 5 in 2017. Once in lunar orbit, a lander will separate from the orbiting spacecraft and land on the Moon. After collecting samples, the lander will return to orbit to rendezvous with the orbiter. Chang'e 5 will then delivery the samples back to Earth in a similar sample return capsule.

While flying around the far side of the Moon, the spacecraft captured a dramatic view of the nearby Moon and distant Earth. The dark patch near the center of the lunar disk is Mare Moscoviense (Sea of Moscow), one of the few, and the largest mare, on the Moon's far side.

Chang'e 5 Test Vehicle Sample Return Capsule
Credit: Xinhua News

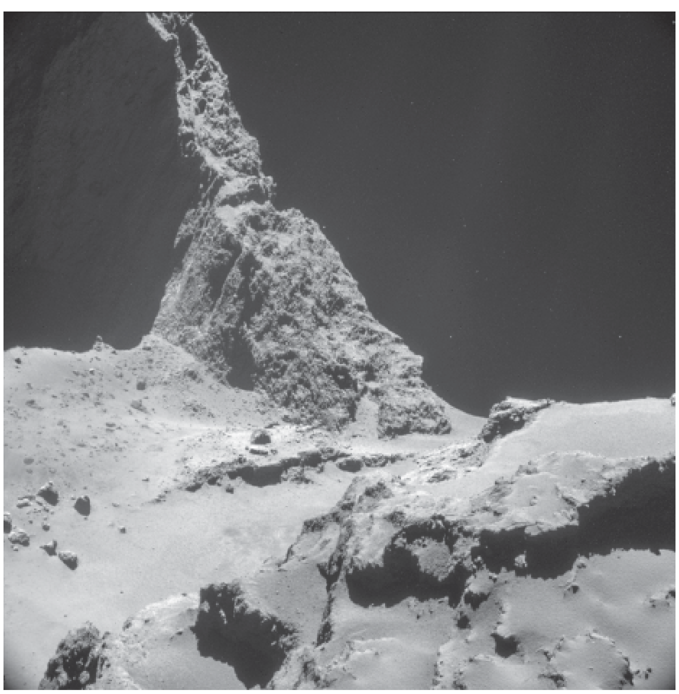
Far side of the Moon and distant Earth
Credit: Xinhua News

Alien Landscape

The photo (below) shows the transition area between the two lobes of Comet 67P/Churyumov–Gerasimenko, with the smaller lobe on the left and the larger lobe on the right. The image was taken by the Rosetta spacecraft from a distance of 4.8 miles (7.7 km) from the comet's surface.

The comet is approximately 3 miles (5 km) in length and 2 miles (3 km)) across. It rotates once every 12.7 hours.

Comet 67P/Churyumov-Gerasimenko's was discovered in 1969 and belongs to a family of comets with periods less than 20 years and gravitationally bound to Jupiter. Analysis of the comet's orbit indicates that its periodicity was much longer in the past than today (at 6.45 years). The comet is believed to have come from the Kuiper Belt, located beyond Neptune. It was a distant and invisible traveler until it passed too close to Jupiter. The encounter(s) modified its orbit, condemning the icy body to the inner solar system and the Sun's ferocity.

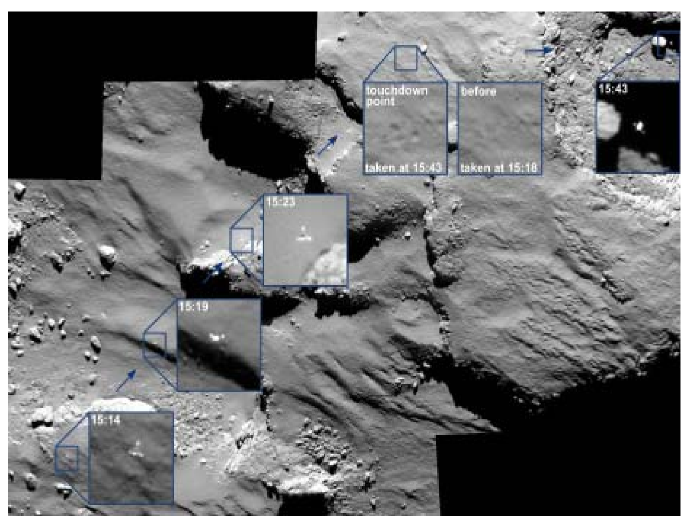


Comet 67P/Churyumov-Gerasimenko. Credit: ESA/Rosetta/ NAVCAM - CC BY-SA IGO 3.0

Seven Hours of Terror

For seven hours on Wednesday, November 12th, Rosetta's lander Philae fell towards the surface of Comet 67P/Churyumov-Gerasimenko. Its stay at the targeted site (called "Agilkia,") was short-lived, as the lander weighing as little as a paperclip in the comet's negligible gravity, bounced back into space after its thruster failed to work and its ice-anchoring harpoons failed to fire.

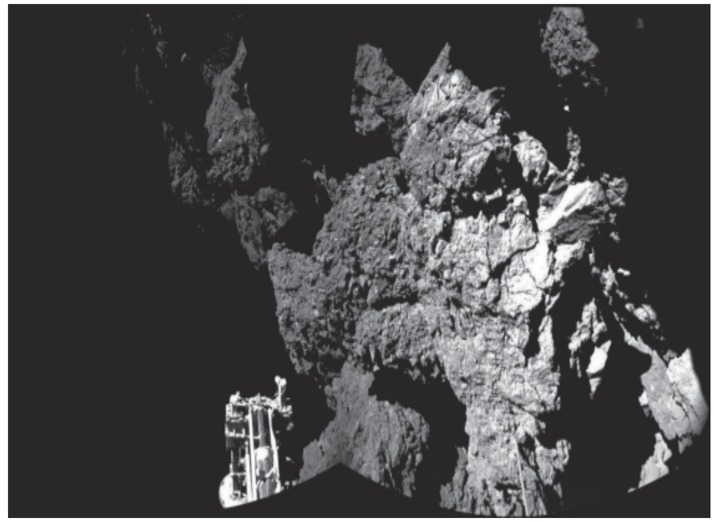
The first bounce sent the lander more than 3,000 feet above surface of the comet, before it fell back again two hours later and downrange of the pre-



A Moaaic of images of the journey of the Philae lander during its 30-minute first touchdown attempt. Image credit: ESA/Rosetta/MPS/UPD/LAM/IAA/SSO/INTA/UPM/DASP/IDA ferred location. Philae fared no better in its second landing, bouncing again, even further from its original landing area and coming to rest in a jumble of rock and ice. The rugged terrain cast shadows across the lander's solar panels, limiting power production to 90 minutes every 12.4 hour day. The limited production from the panels was insufficient to extend the lander's batteries beyond the original 50 to 60 hour charge.

While the lander remained unanchored, its instruments were busy collecting and transmitting data to the Rosetta orbiter. The first mosaic image from the lander (below) includes one of the lander's three feet. Other images indicated that the lander was upright, but deep in shadow or at the base of a cliff. The European Space Agency (ESA) was able to deploy the lander's drill, but it is not known whether it was able to collect and analyze the sample.

By Friday morning, Philae's batteries were depleted and the lander's systems shutdown after completing its primary science mission. While it is unlikely that communications can be restored, lighting conditions may improve as the comet nears the Sun. Countering the rise in solar radiation will be the increasing activity of the comet and the formation of a diffuse coma around the nucleus.



Final resting place of Philae. Credit: ESA/Rosetta/Philae/CIVA

Orion Test Flight

NASA's new deep space crew module, Orion, will venture into space for the first time on December 4th. Orion will be launched (unmanned) aboard a Delta IV Heavy rocket from the Cape Canaveral Air Force Station for a 4½ hour test flight. The flight will take the spacecraft approximately 3,600 miles above the Earth's surface before executing a high-speed return.

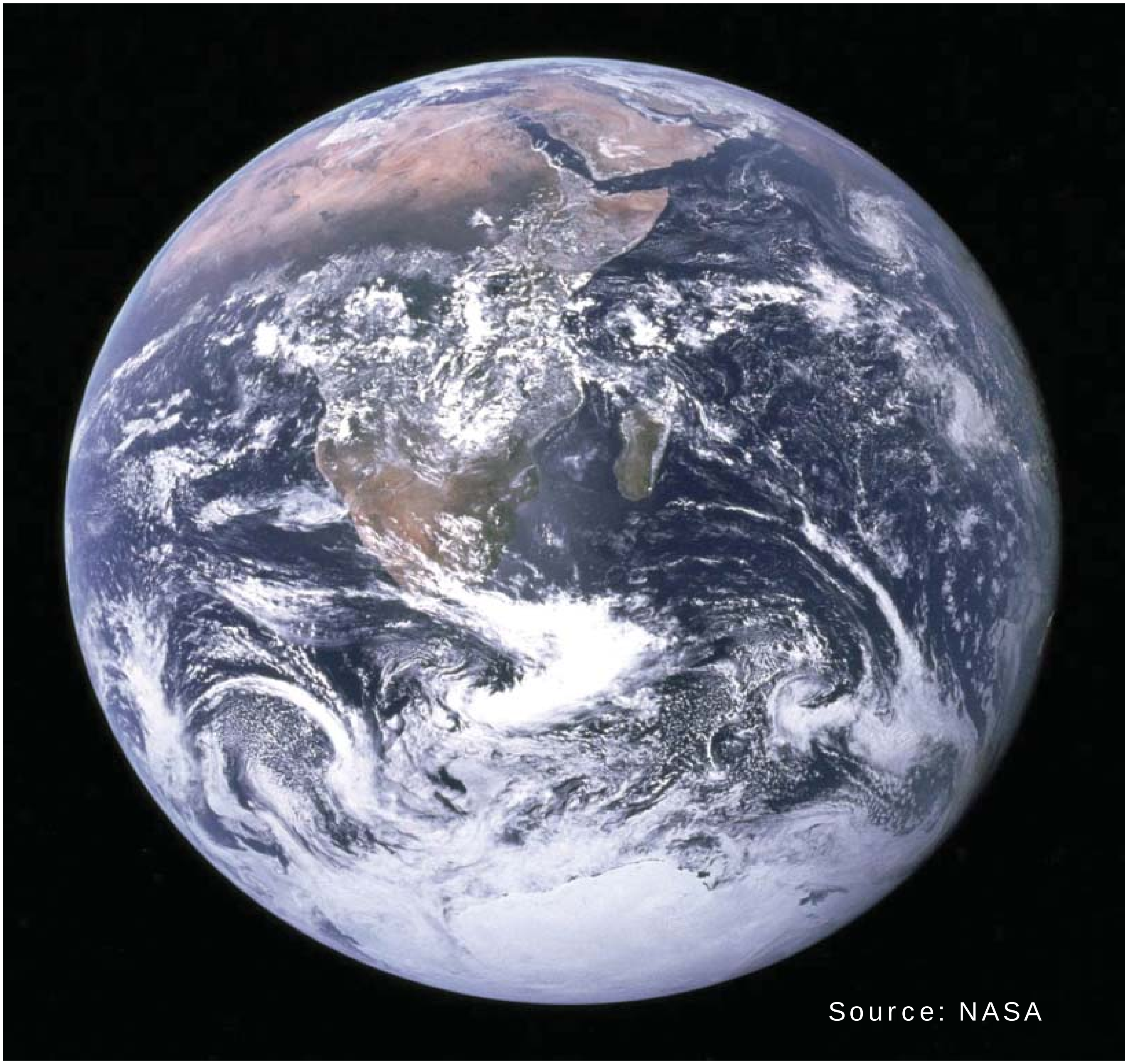
The flight is designed to test heat shield performance (at speeds up to 20,000 mph or 32,187 km/hour and temperatures reaching 4,000°F), guidance and control systems, parachute deployment and recovery operations. The fully assembled spacecraft stands 72 feet tall. Orion has been transported to the launch pad, where it will be lifted 170 feet into the air for mating with a Delta rocket.

Orion Rollout to Launch Pad
Photo Credit: Walter Scriptunas II

Orion Spacecraft
Credit: NASA

Spaceship Earth

On December 7, 1972, the crew of Apollo captured this iconic image of the receding Earth. Christened the "Blue Marble," the image underscored the fragility of humanity's only sanctuary. The photo, taken at a distance of 28,000 miles (45,000 km), provides a view extending from the Mediterranean Sea, across the African continent, to the south polar ice cap.

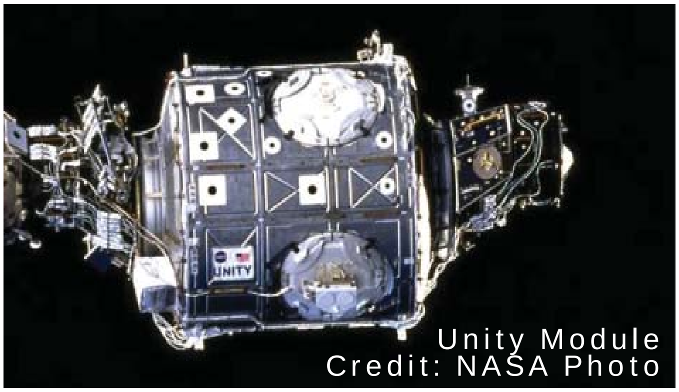


First Construction Flight

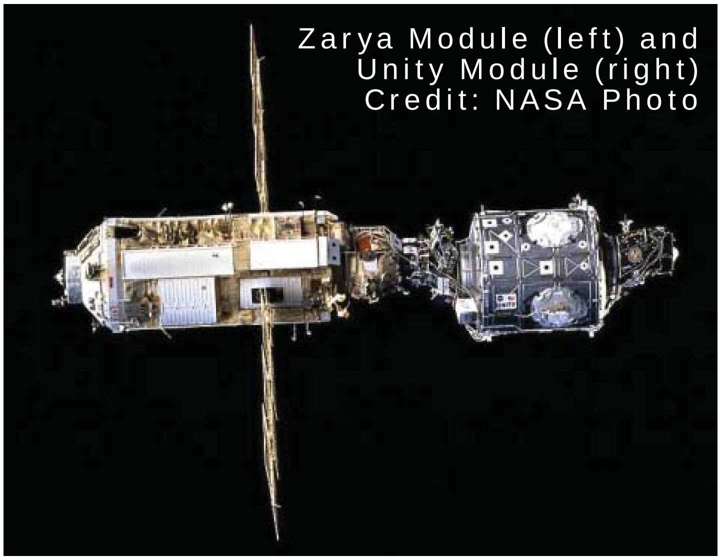
In December 1998, the space shuttle Endeavour carried the first American component of what would become the International Space Station into orbit. The six crew member mated the Unity module with the Russian Zarya control module already on orbit. During three spacewalks, Endeavour's astronauts joined cables and other connectors between the two modules. The astronauts were also able to power up the two modules upon entry. This mission represented the first on-orbit construction flight and the first small step in what would become a 450 ton habitat covering the area of a football field.

Thirteen years later, Endeavor would return to the station for the final shuttle mission, delivering the Alpha Magnetic Spectrometer physics experiment.

Endeavour was also instrumental in the on-orbit repair of the Hubble Space Telescope. In 1993, the shuttle crew conducted the first and most critical repair mission, correcting the optics, replacing the solar arrays and upgrading the wide field planetary camera.



Unity Module
Credit: NASA Photo



Zarya Module (left) and
Unity Module (right)
Credit: NASA Photo

Jovian Photo Opportunity

The natural color image taken by the Hubble Space Telescope's Wide Field Camera 3 captured the shadow of Ganymede, Jupiter's largest moon, as it traversed the Great Red Spot.

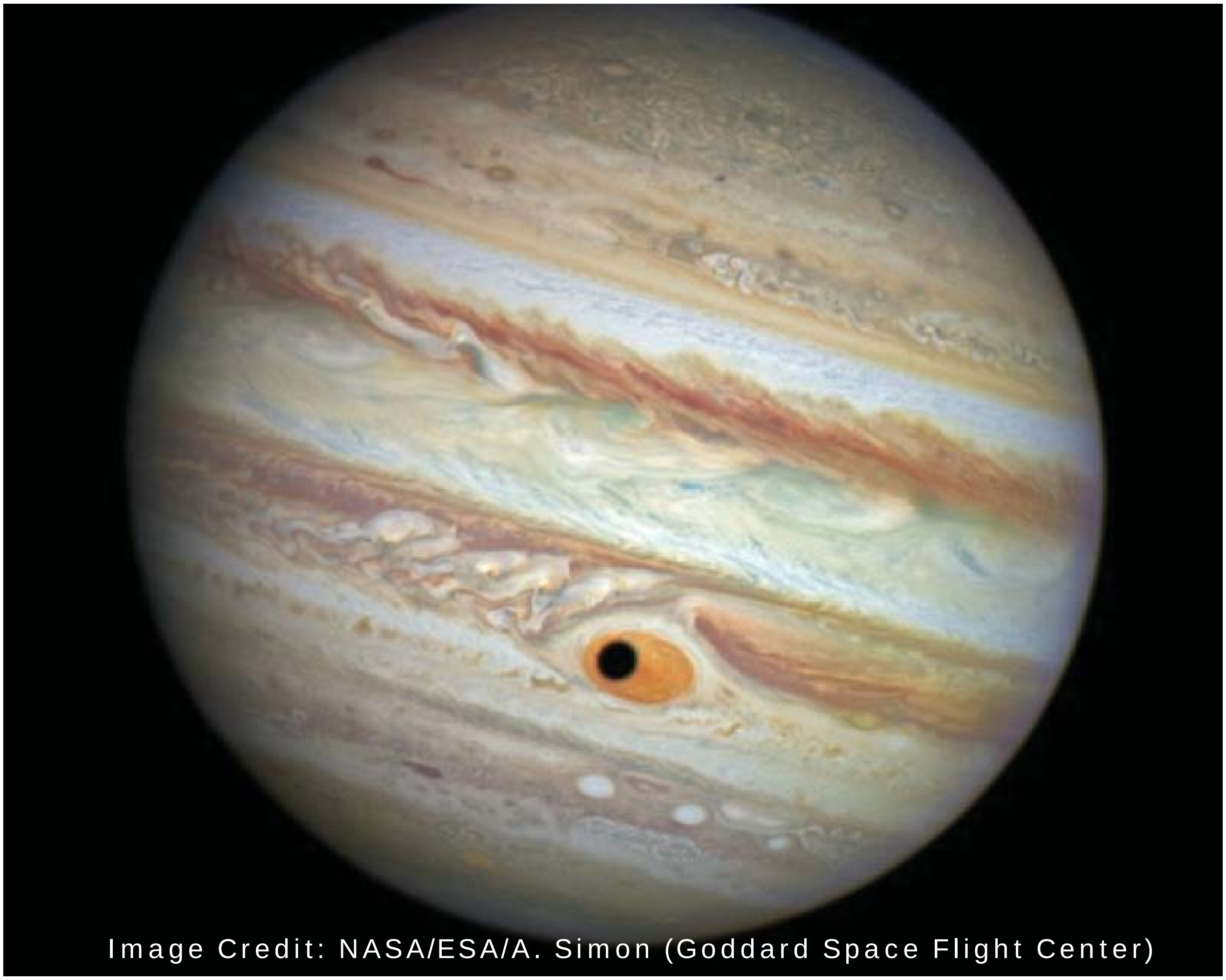


Image Credit: NASA/ESA/A. Simon (Goddard Space Flight Center)

Ganymede is Jupiter's largest moon and the largest satellite in the solar system. Larger than the planet Mercury, Ganymede is three-quarters the size of Mars. Its metallic iron core is surrounded by a mantle of rock and a shell of ice, estimated to be 500 miles (800 km) thick.

The Red Spot is an anti-cyclonic storm, rotating counterclockwise with a period of approximately 6 days. Its cloud tops reach 5 miles (8km) above the surrounding cloud deck. The German amateur astronomer Samuel Heinrich Schwabe was the first to record the storm in an 1831 drawing, although it was likely observed by Giovanni Cassini as early as 1665.

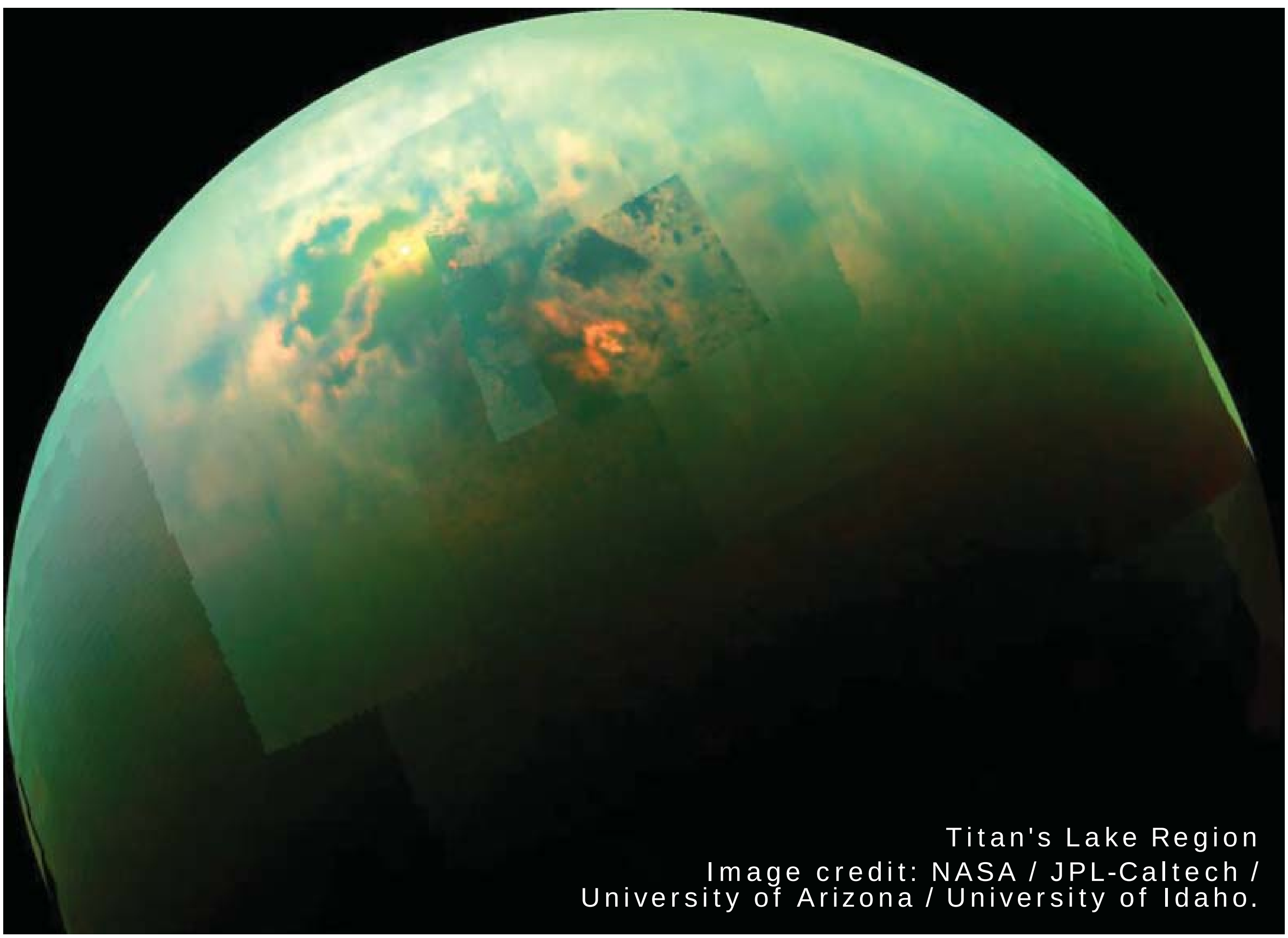
Larger than the Earth, the seemingly permanent feature has been changing, shrinking at an accelerating rate. The latest observations from the Hubble Space Telescope have measured the storm at half the size of some historical estimates. Since 2012, it appears that the Great Red Spot is shrinking by 580 miles (933 km) a year, becoming more circular than oval.

NASA's Juno spacecraft is scheduled to reach the Jovian system in July 2016. The spacecraft may be able to shed some light on the mystery of the disappearing spot.

From Sea to Shining Alien Sea

The Cassini spacecraft uses Titan, Saturn's largest moon, to modify its orbit around Saturn, its inclination to the ringed planet, and to set up flybys of Saturn's numerous moons. In a recent flyby of Titan, Cassini captured the Sun's reflection off the moon's liquid hydrocarbon seas. The seas of liquid methane and ethane seen in the photo are near the moon's north pole.

Kraken Mare is Titan's largest sea, with a surface area approximately 5 times larger than Lake Superior. Radar measurements along the sea's eastern shore have returned depths ranging from 66 to 115 feet (20 to 35 m). The slope of the shoreline leading down to the sea suggests that the sea could be much deeper. Last year radar measurements of another Titan sea (Ligeia Mare) revealed a depth of approximately 560 feet (170 m).



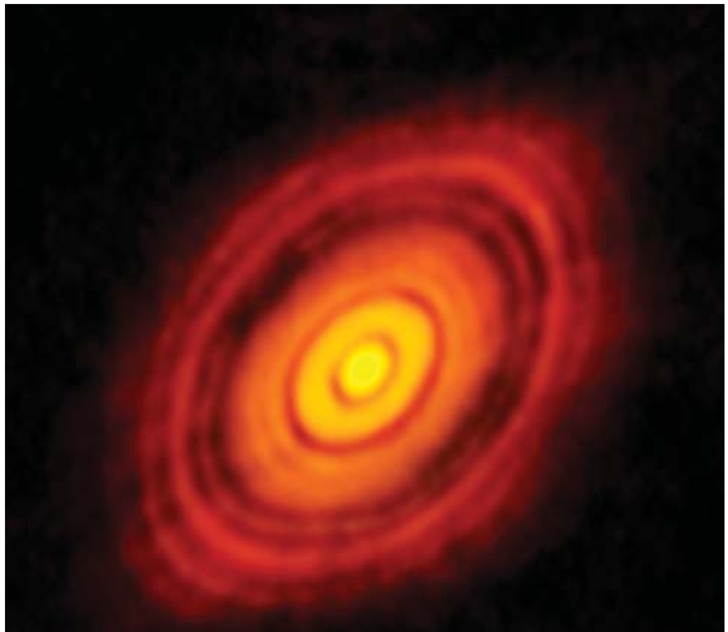
Titan's Lake Region
Image credit: NASA / JPL-Caltech / University of Arizona / University of Idaho.

Planet Formation Observed

The Atacama Large Millimeter/submillimeter Array (ALMA) has captured the early stages of planetary formation around a young star in the constellation Taurus, approximately 450 light years away. The image shows gaps in the disk of gas and dust surrounding the star HL Tauri. The gaps are believed to be created by growing protoplanets (through accretion) sweeping up debris and clearing their orbits.

ALMA is an array of 66 radio telescope antennas that can be reconfigured to create different baselines and, with different baselines, various resolutions. The complex is located in Chile's Atacama Desert at an altitude of 16,400 feet (5,000 m) above sea level. The altitude provides observing conditions relatively free from atmospheric moisture.

Observations of infant solar systems, such as that around HL Tauri, help refine the formation model for our own solar system. Planet formation around a star so young (estimated to be less than a million years old) is already challenging the conventional timeline for the birth of a solar system.



Protoplanetary disk around star HL Tauri
Credit: ALMA (ESO/NAOJ/NRAO)

Atacama Large Millimeter/submillimeter Array (ALMA)
Credit: Christoph Malin

Purchasing a Telescope

During the holidays it's not uncommon to see parents and grandparents carrying around a telescope that they just picked up at the mall or warehouse store for their budding astronomer. Unfortunately, too many of these thoughtful gifts end up in a basement or attic after one or two uses. All too often, telescope manufacturers prey on consumer's expectations, which are often out of line with the capabilities of the product, resulting in frustration and disillusionment. However, even a crudely constructed telescope can be coaxed to produce acceptable images, if the observer understands the limitations of his or her instrument.

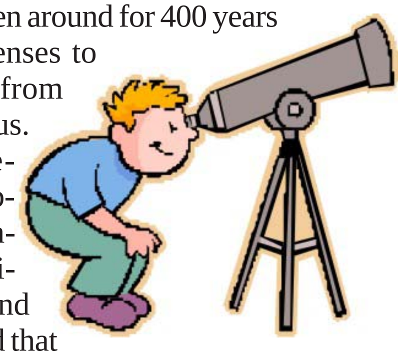
There is no perfect telescope for everyone. An inexpensive, mass-produced telescope that gets carted out of the house and set up every clear night, stimulates the users' imagination and encourages them to push the instrument's capabilities to its limits is far more valuable than the most highly crafted optical masterpiece that spends its nights in a closet.

There are several types of telescopes available to the general consumer. Each has advantages and disadvantages, and with a little education, a consumer can find a telescope that fits his or her needs and lifestyle. Again, if you don't use it, a telescope is about as useful as a garden gnome and not as cute.

Types of Telescopes

There are three basic types of telescopes: refractors, reflectors and compound or catadioptric telescopes.

Refractors have been around for 400 years and use a series of lenses to bring the light rays from distant objects to focus. They are highly regarded for their unobstructed and high-contrast images. The optical tubes are sealed and generally more rugged that other designs. As such, the optics rarely need to be adjusted (realigned) which makes the refractor a good choice as a travel telescope. Refractors are an excellent choice for planetary and lunar viewing and for double stars, but generally do not have the large light gathering capacity needed for faint objects such as nebula and galaxies. The disadvantages of refractors include: the potential for different wavelengths of light to diverge from a common focus as they pass through the glass (producing color "fringing" around bright objects), the position of the eyepiece at the rear of the optical tube (requiring the telescope to be mounted fairly high off the ground for comfortable viewing), the closed tube that can take some time to cool down, and the price (highest cost per inch of aperture of the basic telescopes designs).



Reflectors have been around for almost as long as refractors, but use mirrors instead of lenses to bring light to the observer's eye. A large mirror located at the closed end of the optical tube reflects light back up the tube to a smaller mirror mounted near the open end and out to an eyepiece. Mirrors are much easier and less expensive to manufacture than lenses with only an optical curve required on the front of the mirror. With mirrors, the light never passes through the glass, so there is no divergence of the light rays. However, since the optical tube is open to the atmosphere, mirrors will require periodic cleaning, adjustment and, eventually, recoating. Reflectors offer the best value, particularly for larger apertures.

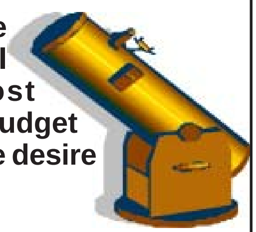
The most popular compound or catadioptric telescopes combine a large, rear spherical mirror with a front corrector lens to create a very compact optical tube. Companies such as Meade and Celestron built their businesses on the Schmidt-Cassegrain design. While generally more expensive than reflectors, the compound telescope offers a very portable alterative for large aperture telescopes. Disadvantages include cool down time (since the optical tubes are sealed), and a relatively large secondary mirror that degrades the image of high contrast objects (planets or the Moon). The front corrector plate is also susceptible to dew formation although this can be managed with a dew shield or corrector plate heater.

There are several terms that are used in the sales promotion of telescopes. Some of the common ones are discussed below:

Aperture

Aperture refers to the size of the largest lens or mirror in the telescope, for example, the primary mirror in an 8-inch reflector is 8-inches in diameter. As a general rule, bigger is better, as light gathering and resolution increase with the size of the optics. However, as with everything else, there are other considerations that limit the practical size of a particular instrument. Alvan Clark & Sons figured the 40-inch lens for the Yerkes Observatory's refractor, delivering the lens in 1897. More than 100 years later, it is still the world's largest working refractor. Why? The weight of the glass and the complexities in supporting a large lens by its edge and the absorption of light passing through the glass were factors; however, the refractor

Dobsonian-type telescopes are reflectors on a simple, swivel mount. They offer a low-cost solution for those on a limited budget with aperture fever (an insatiable desire for a larger telescope).



was ultimately done in by Sir Isaac Newton when he built the first reflecting telescope in 1668. Mirrors, unlike lenses, can be completely supported from the back. Since light does not pass through the glass, reflected images do not suffer from "chromatic aberration." Today single mirrors are routinely produced with diameters exceeding 28 feet and telescopes are constructed combining multiple mirrors to achieve even larger light gathering capabilities. So what size is good for you? Before you answer, you may want to consider:

· Are you planning on setting up your telescope in a permanent installation, e.g., backyard observatory, or will you be moving it in and out of your home every time you plan on observing. If the latter, then weight, portability and ease of set up are important considerations. Due to its size and weight, my telescope saw very little use until I invested in a wheeled platform that allows me to easily roll the fully assembled telescope in and out of my garage in minutes.

· Are you planning on taking your telescope on the road, with you on vacation or planning to travel some distance to find truly dark skies or observe a "once in a lifetime event?" Whether by train, plane or automobile, care must be taken to protect your telescope and ensure that it arrives at its destination in working order (mechanically and optically). If this is important to you, a smaller and simpler design such as a refractor may be a good choice.

· What are you interested in looking at? Spectacular views of the Sun, Moon and planets can be acquired with a relatively modest instrument. However, if your passion is hunting down the more elusive and distant residents our the Milky Way Galaxy or exploring other galaxies far, far, away, it will require a much larger aperture to capture those meager photons.

Magnification

Magnification is likely the most overrated measure of a telescope's capabilities. Magnification is a function of the eyepiece placed in the path of the incoming light and in front of the observer's eye; the observer can change the magnification by simply selecting a different eyepiece. As such, it shouldn't be a criterion in selecting a telescope.

The limiting useful magnification is approximately 50 times the diameter of the objective lens or primary mirror. For example, a small refracting telescope with a 4-inch objective lens can be pushed to a magnification of 200 times; however, only under the best observing conditions and, in general, only on bright objects such as the Moon and planets. Most astronomers prefer the views that lower magnification provides with a wider field and brighter image. So, the next time you are captured by the stunning views of the universe on the packaging of a modest instrument, remember that the potential of most telescopes is rarely realized, particularly if you reside in the light polluted skies of the northeast. A higher power eyepiece magnifies not only the telescope's intended target but also the side-effects of living under 20 miles of Earth's atmosphere.

Mounts

While generally not at the top of the list as far as features, the telescope's mounting system and construction is key to its ease of use and the stability of the image. A poorly designed mount or one with flimsy construction can be just as frustrating to deal with as poor optics. An itude-azimuth or alt-az mount is the est type of telescope mount and genly the easiest to set up. In this arngement, the mount allows the telescope to move left and right while pivoting up and down. It is commonly found on Dobsonian-type telescopes, is user friendly and can be mechanized to track celestial objects across the sky.

Another common mount design is the equatorial mount. In this design, one axis is aligned with the celestial pole, requiring only the movement around this axis to follow objects across the sky. It is the easiest configuration for tracking and is generally preferred for astrophotography. Some alt-az mounts can be converted to an equatorial configuration with the addition of an "equatorial wedge." Equatorial mounts, however, can be heavier than their alt-az counterparts.

Go-To

Essentially a computer controlled pointing system, "go-to" allows the user to select an object from a data base and command the drive motors on the mount to move the telescope to the object's location in the sky.

This presupposes that the telescope user has properly set up the telescope and successfully navigated through the alignment process (a process by which the telescope's computer determines where it's pointed, the local time, and its position on the Earth). Most "go-to" telescopes come with a large database, some of which can be modified (supplemented) by the user. While "go-to" capability is extremely convenient and can take you to thousands of objects in its database in a blink of an eye, it doesn't necessarily mean that you will be able to see the object. Depending upon the size of your telescope (see Aperture), many objects in these databases are just too dim to see with the equipment provided. CCD cameras are much more sensitive than your eye and can accumulate light for long durations. So, if you are planning on using your telescope primarily as a camera lens, then some of the disadvantage of a small aperture can be overcome. However, if you plan on doing most of your observing at the eyepiece, you may want to consider spending the money on a larger aperture rather than on "go-to" electronics.

What to Do

If you are seriously considering acquiring a telescope, a little bit of research can go a long way in enjoying your final purchase. If possible, try to observe through the telescope(s) that you are considering. The McCarthy Observatory has a monthly open house. When the skies are clear, up to a dozen telescopes can be found on the premises (including refractors, reflectors, a Dobsonian, and several Schmidt-Cassegrains). Compare the same celestial objects through different scopes, talk to the owners about portability, ease of setup and operation. Check out product reviews in trade magazines such as Sky and Telescope and Astronomy and on their websites. Contact reputable dealers and visit trade shows such as the Northeast Astronomical Forum where you can pick the brains of industry experts.

December History

1968 was a year of turmoil. The United States was entangled in a war that even the Secretary of Defense concluded could not be won and he resigned from office. The My Lai massacre was one of many atrocities of the Vietnam War perpetrated by both sides during this year. Major U.S. cities were the target of race riots and anti-war protests. Chicago police violently clashed with protesters at the Democratic National Convention and civil rights leader Martin Luther King and presidential candidate Robert Kennedy were assassinated in 1968. To many Americans, the only heartening event in this otherwise horrific year was the reading from the Book of Genesis by the crew of Apollo 8 as they orbited the Moon on Christmas Eve.

The race to beat the Soviets to the Moon took a dramatic turn in 1968 and saw the United States take its first lead by year's end. Apollo 7 was launched in October 1968 into Earth orbit. A week or so later, the Soviets launched two Soyuz space craft into Earth orbit (one manned and one unmanned for a planned rendezvous). In November, another unmanned Zond flew around the Moon and photographed the unseen far side. The United States expected that the Soviets would attempt another moon shot in early December when the launch window for the Baikonur space center in Kazakhstan reopened (a Zond stood poised on the launching pad). Curiously, the opportunity passed without any activity. Cosmonaut Alexei Leonov would later attribute the Soviet's loss of initiative and resolve to the premature death of Sergei Korolev, the "Chief Designer" of the Soviet space program as well as the design complexities of their Moon rocket (the N1).

While Apollo 7 had been a successful maiden voyage of the completely redesigned command module (after the Apollo 1 fire), the United States had yet to leave Earth orbit. NASA's original plan was to launch a series of increasingly complex missions to near-Earth orbit before attempting a lunar excursion. Development of the lunar lander was behind schedule and violent vibrations in the Saturn rocket's main stage needed to be corrected before NASA felt confident of sending men to the Moon. However, the apparent progress by the Soviets threatened to upstage the United States once again. It was a proposal by a quiet engineering genius, George Low, (Manager of the Apollo Spacecraft Program Office) to send the Apollo 8 command module alone into lunar orbit that would ultimately place the United States in a position to achieve President Kennedy's goal to land a man on the Moon and safely return him to Earth by the end of the decade.

Apollo 8 was launched on December 21st under the command of Frank Borman with astronauts William Anders and Jim Lovell (Lovell replaced Michael Collins on the original team; Collins, who required back surgery, would go on to be the Command Module Pilot for Apollo 11). The launch was scheduled so that the crew would arrive at the Moon as the Sun was rising on the Sea of Tranquility. With the Sun low in the sky, the astronauts could photograph potential landing sites and resolve surface detail that would otherwise be washed out in the glare from a higher Sun.

The crew of Apollo 8 was the first to ride the three stage Saturn V rocket, with the explosive energy of an atomic bomb (the Saturn V had only been launched twice before – both unmanned). The night before the launch, the astronauts were visited by Charles Lindbergh. During the visit, it was discussed that the engines on the Saturn V would burn 10 times the amount of fuel every second that Lindbergh had used to fly nonstop from New York to Paris.

The Apollo 8 astronauts were also the first humans to leave Earth orbit and pass through the Van Allen radiation belts that extend up to 15,000 miles from Earth. To accomplish the mission, Apollo 8 had to cross the 240,000 mile void between the Earth and the Moon with sufficient precision so as to intercept the Moon (traveling at 2,300 miles an hour through space) just 69 miles above the lunar surface. By successfully doing so, the astronauts were the first humans to witness the rising of the Earth above the Moon's horizon (Earthrise). They would also be the first to return to Earth and reenter the atmosphere at a speed of 25,000 miles an hour.

The highlight of the mission, to many, was the broadcast from the Apollo 8 command module during the ninth orbit of the Moon. After a brief introduction of the crew and their general impressions of the lunar landscape, William Anders said that the crew had a message for all those on Earth. The astronauts took turns reading from the book of Genesis, the story of creation. Frank Borman closed the broadcast with: "And from the crew of Apollo 8, we close with: Good night, Good luck, a Merry Christmas, and God bless all of you, all you on the good Earth." It is estimated that a quarter of Earth's population saw the Christmas Eve transmission.

In order to safely return to Earth, the main engine had to be restarted on the far side of the Moon (out of contact with the Earth). If successful, Apollo 8 would reappear from behind the Moon at a predetermined time. As predicted, the spacecraft re-emerged on time, and when voice contact was regained, astronaut Jim Lovell would announce: "Please be informed, there is a Santa Claus." It was Christmas Day. Apollo 8 would return safely to the Earth two days later, splashing down in the Pacific Ocean shortly before sunrise. The astronauts and the capsule were recovered by the aircraft carrier USS Yorktown.

December Nights

Nights in December are not to be missed. While the often frigid and turbulent atmosphere can be frustrating for astronomers, the reflection of shimmering starlight (or moonlight) off a snow covered landscape can be truly magical. The bright stars of the winter sky glow with color from orange to yellow to brilliant blue-white. A star-filled sky in December is unsurpassed in grandeur.

Sunrise and Sunset

Sun	Sunrise	Sunset
December 1st (EST)	07:01	16:24
December 15th	07:13	16:24
December 31st	07:20	16:33

Astronomical and Historical Events

1st Kuiper Belt Object 2006 QH181 at Opposition (82.146 AU)
1st History: launch of Soviet satellite Sputnik 6 and two dogs: Pchelka and Mushka (1960)
2nd History: dedication of the John J. McCarthy Observatory in New Milford, CT (2000)
2nd History: launch of SOHO solar observatory (1995)
2nd History: touchdown of Soviet Mars 3 lander: communications were lost with the lander, the first spacecraft to touch down on the Red Planet, after 20 seconds, possibly due to raging dust storm (1971)
2nd History: launch of space shuttle Endeavour (STS-61), first servicing of the Hubble Space Telescope, including the installation of corrective optics and new solar panels (1993)

Astronomical and Historical Events (continued)

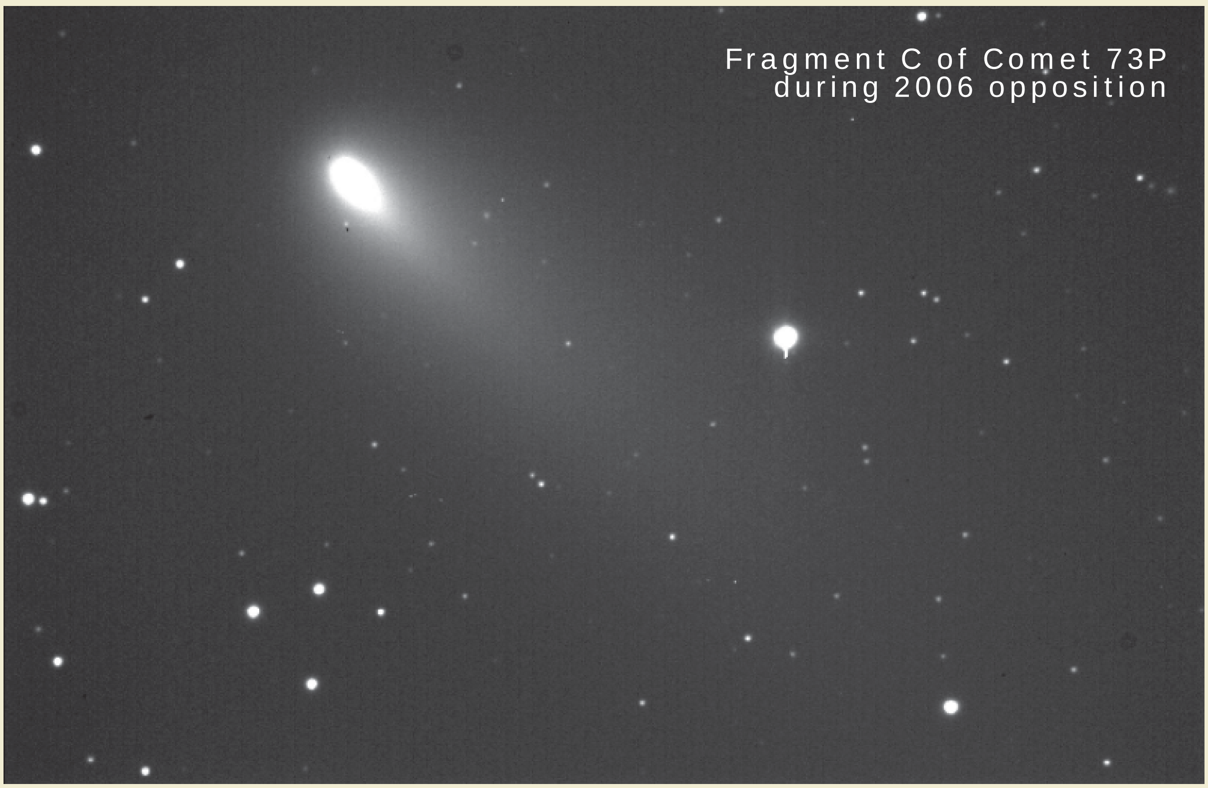
- 2nd History: Pioneer 11 spacecraft makes its closest approach to Jupiter; encounter redirects the spacecraft to Saturn and an escape trajectory out of the solar system (1974)
- 3rd Asteroid 23 Thalia at Opposition (9.2 Magnitude)
- 3rd History: Pioneer 10 spacecraft makes its closest approach to Jupiter; first space probe to fly through the asteroid belt and to an outer planet (1973)
- 3rd History: discovery of Jupiter's moon *Himalia* by Charles Perrine (1904)
- 4th Scheduled launch of the Orion Exploration Flight Test-1 from the Cape Canaveral Air Force Station, Florida
- 4th History: launch of space shuttle Endeavour (STS-88), first International Space Station construction flight, including the mating of the Unity and Zarya modules (1998)
- 4th History: launch of the Pathfinder spacecraft to Mars (1996)
- 4th History: Pioneer Venus 1 enters orbit, first of two orbiters (and probes) to conduct a comprehensive investigation of the atmosphere of Venus (1978)
- 4th History: launch of Gemini Joe 2 rocket, test flight for the Mercury capsule and first U.S. animal flight with Sam, a Rhesus monkey (1959)
- 6th Full Moon (Full Cold Moon)
- 6th Plutino 84922 (2003 VS2) at Opposition (35.592 AU)
- 7th New Horizons spacecraft wakes up from hibernation in preparation for its July 2015 encounter with the dwarf planet *Pluto*
- 7th History: arrival of the Galileo space probe at Jupiter (1995)
- 7th History: launch of Apollo 17 with astronauts Ronald Evans, Harrison Schmitt (first scientist – geologist) and Eugene Cernan (last man on the Moon – so far) (1972)
- 8th Plutino 307463 (2002 VU130) at Opposition (39.797 AU)
- 8th History: a Dragon spacecraft, launched by SpaceX into low-Earth orbit, is recovered in the Pacific Ocean: first time a spacecraft recovered by a commercial company (2010)
- 8th History: discovery of asteroid *5 Astraea* by Karl Hencke (1845)
- 9th Scheduled launch of SpaceX's Dragon spacecraft from the Cape Canaveral Air Force Station on a cargo-carrying mission to resupply the International Space Station; this is SpaceX's fifth resupply flight.
- 9th Kuiper Belt Object 2004 XR190 at Opposition (56.576 AU)
- 9th History: Pioneer Venus 2 enters orbit, second of two orbiters (and probes) to conduct a comprehensive investigation of the atmosphere of Venus (1978)
- 10th Flyby of Saturn's largest moon *Titan* by the Cassini spacecraft
- 10th Kuiper Belt Object 19521 Chaos at Opposition (40.494 AU)
- 10th History: launch of the X-ray Multi-Mirror Mission (XMM-Newton), the largest scientific satellite built in Europe and one of the most powerful (1999)
- 10th History: Claxton meteorite fall; hits mailbox in Georgia (1984)
- 10th History: launch of Helios 1 (also known as Helios A) into solar orbit; joint venture by Federal Republic of Germany and NASA to study the Sun (1974)
- 12th Moon at apogee (furthest distance from Earth)
- 12th History: discovery of Saturn moons Fornjot, Farbauti, Aegir, Bebhionn, Hati and Bergeimir by Scott Sheppard, et al's (2004)
- 12th History: discovery of Saturn moons Hyrrokkin by Sheppard/Jewitt/Kleyna's (2004)
- 12th History: launch of Oscar, first amateur satellite (1961)
- 13th Second Saturday Stars - Open House at the McCarthy Observatory (7:00 pm)
- 13th Geminids Meteor Shower peak
- 13th Plutino 55638 (2002 VE95) at Opposition (28.236 AU)
- 13th History: discovery of Saturn's moons Fenrir and Bestla by Scott Sheppard, et al's (2004)
- 13th History: Mt. Wilson's 100-inch telescope used to measure the first stellar diameter (Betelgeuse); measured by Francis Pease and Albert Michelson (1920)
- 13th History: First light of Mt. Wilson's 60-inch telescope (1908)

Astronomical and Historical Events (continued)

14th Last Quarter Moon
14th History: flyby of Venus by Mariner 2; first spacecraft to execute a successful encounter with another planet, finding cool cloud layers and an extremely hot surface (1962)
14th History: flyby of Mars by Japan's Nozomi spacecraft after an attempt to achieve orbit fails (2003)
14th History: Weston meteorite fall: first documented fall in the United States (1807); best coordinates for the fall are based upon investigative research by Monty Robson, Director of the McCarthy Observatory, published in 2009
14th History: birth of Tycho Brahe, Danish astronomer noted for his observational skills, the precision of his observations, and the instruments he developed; builder of Uraniburg, the finest observatory in Europe (1546)
15th History: launch of Soviet spacecraft, Vega 1 to Venus and then to Comet Halley (1984)
15th History: landing of Soviet spacecraft Venera 7 on the surface of Venus (1970)
15th History: discovery of Saturn's moon *Janus* by Audouin Dollfus (1966)
15th History: launch of Gemini 6 with astronauts Walter Schirra and Thomas Stafford (1965)
16th History: launch of Pioneer 6, the first of four identical solar orbiting, spin-stabilized spacecraft (1965)
17th History: Project Mercury publicly announced (1958)
17th History: Wright Brothers' first airplane flight, Kitty Hawk, N.C. (1903)
19th History: launch of the Gaia spacecraft from French Guiana to survey more than one billion stars in an effort to chart the chart the evolution of the Milky Way galaxy (2013)
19th History: launch of space shuttle Discovery (STS-103), third servicing of the Hubble space telescope including the installation of new gyroscopes and computer (1999)
19th History: launch of Mercury-Redstone 1A; first successful flight and qualification of the spacecraft and booster (1960)
20th Plutino 2002 XV93 at Opposition (38.170 AU)
20th History: Ames Research Center founded as the second National Advisory Committee for Aeronautics (NACA) laboratory at Moffett Federal Airfield in California (1939)
20th History: founding of the Mt. Wilson Observatory (1904)
21st Winter Solstice at 21:23:03 UT (4:23 pm EST)
21st New Moon
20th History: launch of the Active Cavity Radiometer Irradiance Monitor satellite (ACRIMSAT); designed to measure Sun's total solar irradiance (1999)
21st History: launch of the Soviet spacecraft Vega 2 to Venus, continued on to Comet Halley (1984)
21st History: landing of Soviet spacecraft Venera 12 on the surface of Venus, found evidence of thunder and lightning in the atmosphere (1978)
21st History: launch of Apollo 8 with astronauts Frank Borman, Jim Lovell and William Anders, first to circumnavigate the Moon (1968)
21st History: launch of Luna 13, Soviet moon lander (1966)
22nd Ursids Meteor Shower peak
22nd History: discovery of the Mars meteorite LEW 88516 (1988)
23rd History: discovery of Saturn's moon *Rhea* by Giovanni Cassini (1672)
24th Moon at perigee (closest distance from Earth)
24th History: inaugural of ESA's Ariane 1 rocket and first artificial satellite carried by a ESA rocket (1979)
24th History: Deep Space Network created (1963)
24th History: Jean-Louis Pons born into a poor family with only basic education, took post at observatory at Marseilles as concierge, went on to become most successful discover of comets (discovered or co-discovered 37 comets, 26 bear his name) (1761)
24th History: inaugural launch of the Arianne rocket, Europe's attempt to develop a cost-effective launcher to serve the commercial market (1979)
25th History: European Space Agency's Mars Express spacecraft enters orbit around Mars (2003)

<u>Astronomical and Historical Events</u> (continued)

25th History: landing of Soviet spacecraft Venera 11 on Venus, second of two identical spacecraft (1978)
26th History: launch of Soviet space station Salyut 4 from Baikonur Cosmodrome; third Soviet space station and second space station devoted primarily to civilian objectives; deorbited in 1977 (1974)
27th History: discovery of the ALH84001 Martian meteorite in the Allan Hills, Far Western Icefield, Antarctica, made famous by the announcement of the discovery of evidence for primitive Martian bacterial life (1984)
27th History: Johannes Kepler born, German mathematician and astronomer who postulated that the Earth and planets travel about the sun in elliptical orbits, developed three fundamental laws of planetary motion (1571)
28th First Quarter Moon
29th Comet 73P/Schwassmann-Wachmann at Opposition (4.104 AU); the comet began to breakup into several fragments in 1995, by 2006, 19 fragments were being tracked, with fragment C being the largest



30th Asteroid 25143 Itokawa closest approach to Earth (1.611 AU); asteroid was target of Japan's spacecraft Hayabusa and sample return mission
30th History: flyby of Jupiter by Cassini spacecraft on mission to Saturn (2000)
30th History: discovery of Uranus' moon Puck by Stephen Synnott (1985)
31st Asteroid 10 Hygiea at Opposition (10.0 Magnitude)
31st History: GRAIL-A, lunar gravity mapping spacecraft enters orbit (2011)

References on Distances

• The apparent width of the Moon (and Sun) is approximately one-half a degree (½°), less than the width of your little finger at arm's length which covers approximately one degree (1°); three fingers span approximately five degrees (5°)

• One astronomical unit (AU) is the distance from the Sun to the Earth or approximately 93 million miles

International Space Station/Space Shuttle/Iridium Satellites

Visit *www.heavens-above.com* for the times of visibility and detailed star charts for viewing the International Space Station, the Space Shuttle (when in orbit) and the bright flares from Iridium satellites.

Solar Activity

For the latest on what's happening on the Sun and the current forecast for flares and aurora, check out *www.spaceweather.com.*

Image Credits

Front page design and graphic calendar: Allan Ostergren
Second Saturday Stars poster: Sean Ross, Ross Designs

All other non-credited photos were taken by the author: Bill Cloutier

Second Saturday Stars

FREE EVENT

Every Month at the

John J. McCarthy Observatory

Behind the New Milford High School

860.946.0312

www.mccarthyobservatory.org

December 13th

7:00 - 9:00 pm

NASA Spin Offs

ENRICHED BABY FOOD

ANTI-CORROSION COATINGS

LEDs

GPS

MULTIVITAMINS

SATELLITE MAPS

FREEZE DRYING

COCHLEAR IMPLANTS

UAVs

INVISIBLE BRACES

INFRARED THERMOMETERS

SATELLITE TV

CORDLESS TOOLS

CELL PHONE CAMERAS

SCRATCH RESISTANT LENSES

VIDEO GAME JOYSTICKS

UV SUNGLASSES

WATER PURIFICATION

DRY ELECTRODES

MODERN INSULATION

CAT SCANNERS

POWDERED LUBRICANTS

Refreshments
Family Entertainment
Activity Center
Stars & Planets
Rain or shine

December 2014

Celestial Calendar

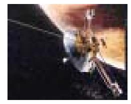
Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday

1 (Monday)

Launch of Soviet satellite Sputnik 6 with two dogs, Pchelak and Mushka (1960)

2 (Tuesday)
Flyby of Jupiter by Pioneer 11 spacecraft (1974)


Launch of SOHO solar observatory (1995)
Space Shuttle Endeavour first Hubble servicing mission (1993)
Dedication of John J. McCarthy Observatory in New Milford, CT (2000)


3 (Wednesday)

Pioneer 10 closest approach to Jupiter (1973)

Discovery of Jupiter moon Himalia by Charles Perrine (1904)

4 (Thursday)
Orion test flight launch, Cape Canaveral


Gemini 7 launch - Borman/Lovell (1965)
Launch of Pathfinder spacecraft to Mars (1996)

Pioneer orbits Venus to study atmosphere (1978)
Launch of Little Joe 2 rocket, test flight for the Mercury capsule with Sam, a Rhesus monkey (1959)

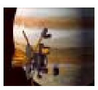

5 (Friday)

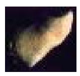
Discovery of Kepler-22b, by NASA's Kepler Space Telescope in the constellation of Cygnus - the first known transiting planet to orbit within the habitable zone of a Sun-like star (2011)

6 (Saturday)

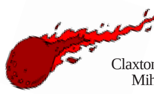
America's first attempt at putting a satellite into orbit failed as Vanguard TV3 rose only about four feet off a Cape Canaveral launch pad before crashing back down and exploding (1957)

7 (Sunday)
Apollo 17 (Evans, Schmitt, Cernan) 1972

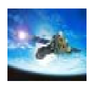

Gerard Kuiper born - proposed belt of minor planetary objects beyond Neptune (1905)
Arrival of Galileo space probe at Jupiter (1995)

New Horizons spacecraft wakes up to prepare for its July 2015 encounter with the dwarf planet Pluto

8 (Monday)
Discovery of asteroid 5 Astraea by Karl Hencke (1845)

Galileo spacecraft 1st Earth flyby (1990)
SpaceX Dragon, launched into low-Earth orbit, is recovered in the Pacific Ocean: first by a commercial company (2010)

9 (Tuesday)

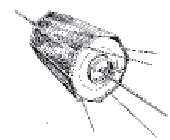
Pioneer Venus 2 in orbit, 2nd to study planet's atmosphere (1978)
Ausson meteorite fall, hits building in France (1858)

Asteroid 2011 WU4 Near-Earth Flyby (0.084 AU)

10 (Wednesday)

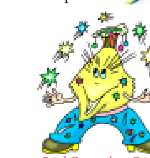
Launch of Helios 1 into solar orbit - joint project of NASA and Federal Republic of Germany (1974)
St Louis meteorite, hits automobile (1950)
Claxton, GA, hits mailbox (1984)
Mihonoseki, Japan, hits house (1992)
Launch of XMM-Newton European X- Ray satellite (1999)


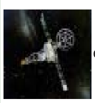
11 (Thursday)

Challenger, the Lunar Lander for Apollo 17, touched down on the Moon's surface with astronauts Harrison Schmitt and Eugene Cernan - last two men to walk on moon (1972)

12 (Friday)
Moon at apogee (farthest from Earth)

Launch of Oscar, first amateur satellite (1961)

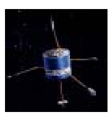
13 (Saturday)

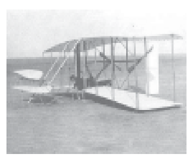
First light of Mt. Wilson's 60-inch telescope (1908)
Geminids meteor shower peak

2nd Saturday Stars
New Milford High School

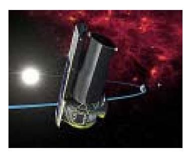
14 (Sunday)

Flyby of Venus by Mariner 2; first spacecraft to execute a successful encounter with another planet (1962)
Weston, CT Meteorite, first documented U.S. strike (1807)
Tycho Brahe born, 1546 - Danish astronomer

15 (Monday)
Discovery of Saturn moon Janus by Audouin Dollfus (1966)
Soviet Venus missions: landing of Venera 7 on the surface of Venus (1970); Vega 1 to Venus and Comet Halley (1984);

Gemini 6 launch (Schirra, Stafford) 1965

16 (Tuesday)
Launch of Pioneer 6, first of four solar orbiting spacecraft (1965)

Mars origin meteorite QUE 94201 discovered in Queen Alexandra range, Antarctica (1994)

17 (Wednesday)

Wright Brothers first flight, Kitty Hawk, NC (1903)

18 (Thursday)

NASA showed the first images from the $670 million Spitzer Space Telescope, launched 4 months earlier (2003)

19 (Friday)
Mercury 1, unmanned spacecraft (1960)
Launch of Discovery STS-103, 3rd Hubble servicing mission (1999)

Benares meteorite, hits house in India (1798)

20 (Saturday)
Founding of the Mt. Wilson Observatory (1904)
Soviet cosmonaut Georgy Grechko makes the first spacewalk during the Salyut 6 EO-1 mission (1977)

Comet 21P Giacobini–Zinner discovered in the constellation Cygnus by Michel Giacobini from (Nice, France) (1900)

21 (Sunday)
Winter Solstice at 21:23:03 UT (4:23 pm EST)
Launch of Soviet spacecraft Vega 2 to Venus and on to Comet Halley - (1984)
Apollo 8 (Borman, Lovell, Anders), first to circumnavigate the Moon - 1968

Launch of Luna 13, Soviet moon lander (1966)

22 (Monday)

Discovery of LEW 88516 meteorite -Martian origin (1988)
Ursids meteor shower peak

23 (Tuesday)


Discovery of Saturn's moon Rhea by Giovanni Cassini (1672)

24 (Wednesday)
Moon at perigee (closest distance to Earth)
inaugural launch of the Ariane rocket (1979)
Jean-Louis Pons born - discoveror of comets (1761)

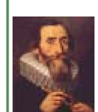
Deep Space Network created (1963)

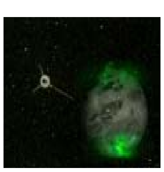
25 (Thursday)
Mars Express spacecraft orbits Red planet (2003)

Launch of Soviet Salyut 4 space station (1974)
Venera 11 on Venus, 4 days after sister lander Venera 12 (1978)

26 (Friday)

Charles Babbage born - British mathematician, co-founder of Royal Astronomical Society and inventor of first mechanical computer (1791)

27 (Saturday)

Johannes Kepler born 1571 - established laws of planetary motion
ALH 84001 meteorite in Antarctica - cross section shows signs of possible Martian bacterial life (1984)

28 (Sunday)

Galileo spacecraft explores auroras during eclipse of Jovian moon Ganymede (2000)

29 (Monday)

Nancy Jane Sherlock Currie born - an engineer, US Army officer and a NASA astronaut, designed hardware for space station and served on four shuttle missions (1956)

30 (Tuesday)
John Michel born, gravity scientist and first to predict existence of "dark stars", later called black holes (1724)
Discovery of Uranus' moon Puck by Stephen Synnott (1985)
Cassini meets Galileo at Jupiter and gets Jovian gravity boost, while en route to Saturn (2000)

31 (Wednesday)
GRAIL-A spacecraft (Gravity Recovery And Interior Laboratory) enters lunar orbit, to be followed by GRAIL-B the following day. Duo will map the moon's gravity field (2011)

Phases of the Moon

Full Moon — Dec 6
Waning Gibbous
Last Quarter — Dec 14
Waning Crescent
New Moon — Dec 21
Waxing Crescent
First Quarter — Dec 28